



**Grade 5**  
**Reducing Friction Investigation**  
*Teacher Guide*

**Winter 2001**



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## Reducing Friction Investigation Teacher Instructions

Friction is the resistance to the motion of an object past another object when the objects are in contact with each other. Students should be familiar with the heat they feel, due to friction, when they rub the palms of their hands together. The students can reflect that it is easier to push an object that has wheels or rollers than it is to push the same size object in direct contact across a flat surface. This investigation examines how rollers affect friction between two objects compared to moving one object across another while the two remain in contact. In this investigation, students will respond to this question:

**How does the use of rollers affect the force required to move a book (or books) a given distance along a surface?**

Each teacher will be provided with a **Reducing Friction Investigation Teacher Guide**, a **Reducing Friction Investigation Student Journal** for each student, and the materials necessary to conduct the investigation.

### Procedure:

- Step 1** Review this document to help you prepare for classroom discussion.
- Step 2** Collect the necessary materials and display them where students will have easy access to them. Allocating the materials in amounts needed by a group of 3 to 4 students will leave more class time for the actual investigation.

**Materials** (for each group of three to four students):

#### Provided by MEAP

1. **Reducing Friction Investigation Student Journals** (1 for each student)
2. string
3. 1 large paperclip
4. 20 large washers to use as weights
5. 30 plastic drinking straws
6. meter stick

#### Provided by the School

1. masking tape
2. 2 paperback books with dimensions  $2.5 \times 10 \times 17.5$  cm (approximately) printed on coarse, lightweight paper
3. level work surface (table)

- Step 3** Organize the class into investigation groups of three to four students.

**Step 4** Pass out one **Reducing Friction Investigation Student Journal** to each student. Make certain that each student writes his or her name on the cover. Impress upon students the importance of having a complete journal to use as a reference when they take the MEAP science test.

**Step 5** Set up a table to demonstrate the arrangement to be used in the investigation.

- Place a 50 cm strip of masking tape along the edge of the table.
- Place a loop of string through the paperback book.
- Have a paperclip and washers on hand.

Say to the students, “In this investigation, you will be measuring the force required to move a book across the table. You will attach a paperclip hook to the string and place washers on the hook to apply the force. You can count the washers to measure the force.”

**Step 6** Present the question being investigated. Say, “The purpose of this investigation is to answer the question: **How does the use of rollers affect the force required to move a book (or books) a given distance along a surface?**”

Write this question on the board or display it as a poster. Have each student copy the question in the *Our Question* section (page 3) of his or her student journal.

**Step 7** Say to the students, “Let’s discuss what we already know that might help us answer the question.” Then discuss the setting (i.e., the real world context) of the investigation. Be certain that the students understand that friction is the resistance to the motion of an object past another object when the objects are in contact with each other. Demonstrate moving objects in contact with each other (e.g., the rubbing of palms together, sliding the soles of sneakers across the floor, etc.) so that students understand that movement of objects in contact produces friction. In order to move, the object must overcome the friction by applying force. The more friction, the more force is needed. The less friction, the less force is needed.

Discuss ways of reducing friction such as lubricants, rollers, etc.

When you are certain that all students understand these concepts, you can summarize them on the chalkboard. Have each student complete the *What I Already Know* section (page 3) of his or her journal.

**Step 8** In mind of the class discussion and the investigation question, have each student complete the *What I Think Will Happen — My Hypothesis* section (page 3) in his or her journal.

**Step 9** Demonstrate the procedure that students will follow.

1. Attach masking tape to a flat work surface, such as a table. The tape should start at the outside edge of the table and extend 50 cm toward the center. (see Figure 1)

2. Loop the string through one of the paperback books along the spine. (see Figure 2)

3. Place the spine of this book in the middle of the table, even with the back edge of the tape. Let the string hang off the edge of the table at least 50 cm from the floor. (see Figure 1)

4. Predict how many weights (washers) will be needed to move the book.

5. Open a paperclip to make a hook for the weights.

6. Record the number of weights needed to move the book to the edge of the table.

7. Repeat the investigation with the following change. Line up the plastic straws 2.5 cm apart, perpendicular to the tape. The straws should extend from the edge of the table to 10 cm beyond the back edge of the tape (see Figure 3).

8. Place the book on the rollers (straws) with the spine even with the back edge of the tape.

9. Predict how many weights will be needed to move the book.

10. Add weights until the book moves to the edge of the table.

11. Record the number of weights needed to move the book.

12. Repeat steps 3 through 11 using two books. Place the second book on top of the book with the loop of string.

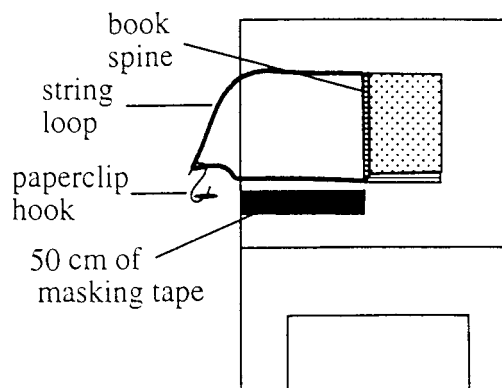


Figure 1

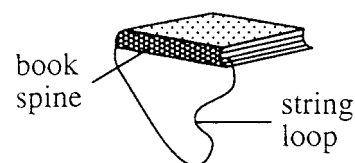


Figure 2

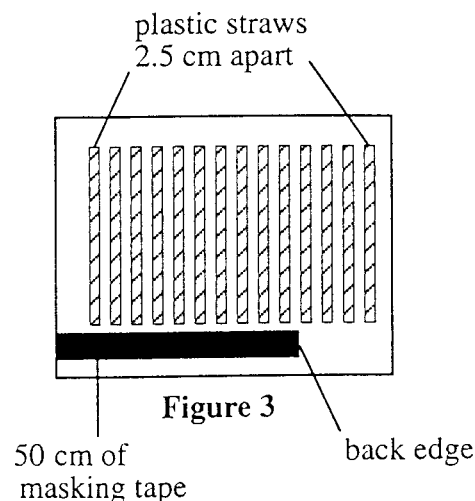


Figure 3

- Step 10** Before you instruct the groups to begin, remind them to complete the table and write notes in the *My Observations* section (page 5) of their journals as they perform the investigation. They should write down their predictions before using the washers to move the book(s). Also instruct students to complete the *Summary of My Results* section (page 6) of their journals as soon as they have finished the investigation.
- Step 11** When all groups have finished the investigation, hold a class discussion of findings and conclusions. Pay special attention to conclusions that do not agree with the general findings and possible errors in investigation procedure. Repeat the investigation if necessary.
- Step 12** Have students use the information in the discussion to complete the final sections on page 6 of their journals.
- Step 13** Direct the students to hand in their completed journals. The journals are to be kept in a safe place and returned to the students just before they take the MEAP science test.

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## Reducing Friction Investigation Sample Student Responses

This information is provided by MEAP as a reference guide for the **Reducing Friction Investigation Student Journal**. The format in this document is similar to the format of the **Reducing Friction Investigation Student Journal**. The sample answers provided may not necessarily reflect your students' work.

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**MEGOSE Objective(s):** PMO02, C02, R01, R04

**Michigan Science Curriculum Framework Benchmarks:** IV.3ES2, I.1ES2, II.1ES1, II.1ES4

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### Our Question

The question we are going to investigate is:

How does the use of rollers affect the force required to move a book (or books) a given distance along a surface?

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### What I Already Know

Here are some things I already know about the question:

The more friction, the more force needed to move an object.

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Friction produces heat.

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Different surfaces have different amounts of friction.

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### What I Think Will Happen — My Hypothesis

This is what I think will happen:

The book (or books) on rollers will take less force to move than the book (or books) on the table.

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**Materials That We Will Use** (for each group of 3 to 4 students)

1. **Reducing Friction Investigation Student Journals** (1 for each student)
2. string
3. 1 large paperclip
4. 20 large washers to use as weights
5. 30 plastic drinking straws
6. meter stick
7. masking tape
8. 2 paperback books with dimensions  $2.5 \times 10 \times 17.5$  cm (approximately) printed on coarse, lightweight paper
9. level work surface (table)

**Procedure**

1. Attach masking tape to a flat work surface, such as a table. The tape should start at the outside edge of the table and extend 50 cm toward the center.
2. Loop the string through one of the paperback books along the spine.
3. Place the spine of this book in the middle of the table, even with the back edge of the tape. Let the string hang off the edge of the table at least 50 cm from the floor.
4. Predict how many weights (washers) will be needed to move the book.
5. Open a paperclip to make a hook for the weights.
6. Record the number of weights needed to move the book to the edge of the table.
7. Repeat the investigation with the following change. Line up the plastic straws 2.5 cm apart, perpendicular to the tape. The straws should extend from the edge of the table to 10 cm beyond the back edge of the tape.
8. Place the book on the rollers (straws) with the spine even with the back edge of the tape.
9. Predict how many weights will be needed to move the book.
10. Add weights until the book moves to the edge of the table.
11. Record the number of weights needed to move the book.
12. Repeat steps 3 through 11 using two books. Place the second book on top of the book with the loop of string.



## My Observations

### Reducing Friction Data Table

Number of Books	Friction Setup	Predicted Weights	Weights Needed
1	on table	8	10
1	on rollers	4	1
2	on table	13	17
2	on rollers	6	3

## Notes About the Investigation

The 2.5 cm between straws changes as the blocks move across the straws.

The straws move closer together.

### Summary of My Results

The summary of my results:

Fewer washers are needed to move the book or books across the rollers than to move the same book or books across the table surface. More washers are needed to move two books than to move one book, whether on rollers or on the table surface.

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### My Answer to the Question

My answer to the question is:

Rollers reduced the amount of force (weight) needed to move the book (or books) compared to moving the book (or books) in contact with the table. The amount of weight used to move the books on the rollers was less than the amount of weight needed to move the books across the table surface.

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### My Reasons for My Answer

I think this is the answer because I observed:

Rollers can be used as a simple machine to make work easier by reducing friction.

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### Possible Errors

These are the things that might have caused errors in my investigation:

It was difficult to maintain an even distance (2.5 cm) between the rollers.

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The surface of the table was not clean.

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The table had surface irregularities such as scratches and small cracks.

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The surface of the table was not the same across the 50 cm on which the book moved.

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**Additional Notes**

